

REMARKS/ARGUMENTS

Claims 1-14 are pending.

Claims 2 and 13-14 have been amended.

Support for the amendments is found in the claims and specification (e.g., paragraphs 14, 16, 19, and 27), as originally filed.

No new matter is believed to have been added.

Applicants wish to thank the Examiner for a discussion conducted on May 17, 2011. It was explained by the Applicants' representative that Tatsumisago et al. do not describe all claimed peaks and, specifically, at least two peaks  $2\theta = 21.8 \pm 0.3$  deg and  $23.8 \pm 0.3$  deg; "small peaks" pointed to by the Examiner are not real peaks but are merely measurement errors. The Examiner indicated that submitting a declaration by Mr. Tatsumisago explaining that "small peaks" pointed to by the Examiner are not real peaks would be sufficient to overcome the rejections. The disclosures of Kugai et al. and Hayashi et al. were also discussed.

Claims 1, 8, and 10 are rejected under 35 U.S.C. 102(b) over Tatsumisago et al., Solid State Ions, 154-155:3-8 (2002). Claims 13-14 are rejected under 35 U.S.C. 103(a) over Tatsumisago et al., in view of Kugai et al., US 2004/0005504. The rejections are traversed because Tatsumisago et al. alone or in combination with Kugai et al. do not describe or suggest (a) crystallized glass having eight diffraction peaks including peaks at  $2\theta = 21.8 \pm 0.3$  deg and  $23.8 \pm 0.3$  deg and (b) the composition of claims 13-14.

(1) The claimed crystallized glass

The claimed glass is a crystallized glass obtained by sintering a sulfide-based glass formed from a mixture having a specific composition ( $\text{Li}_2\text{S}$ : 68 to 74 mol% and  $\text{P}_2\text{S}_5$ : 26 to 32 mol%) at a certain temperature (150 to 360°C), which has eight characteristic diffraction

peaks, as in claim 1. The crystallized glass exhibits an extremely high ionic conductivity (see Table 1 of the present specification).

(2) The disclosure of Tatsumisago et al. compared to the claimed crystallized glass.

Fig. 6 of Tatsumisago et al. (attachment 3 submitted with the previous response) clearly shows that the Tatsumisago et al. crystallized glass does not have diffraction peaks at  $2\theta = 21.8 \pm 0.3$  deg and  $23.8 \pm 0.3$  deg compared to the claimed crystallized glass having eight diffraction peaks including the peaks at  $2\theta = 21.8 \pm 0.3$  deg and  $23.8 \pm 0.3$  deg, as shown in the enclosed enlarged Fig. 2 of the present specification (attachment 4 submitted with the previous response).

The Declaration of Tatsumisago et al., submitted herewith, explains that the “small peaks” pointed to by the Office on page 4 of the Official Action mailed on February 1, 2011, are not real peaks but are merely measurement errors.

Therefore, the claimed crystallized glass is different from the glass shown in Fig. 6 of Tatsumisago et al.

This difference is because the crystallized glass of Fig. 6 of Tatsumisago et al. is obtained by heating mechanically milled powders having a composition of  $\text{Li}_2\text{S}$ : 80 mol% and  $\text{P}_2\text{S}_5$ : 20 mol%, as shown in the bottom note of Fig. 6, which is different from the composition of the raw material of claims 13-14.

Table 1 of the present specification shows that desired crystallized glass cannot be obtained when the components of the glass composition are not within the claimed specific range (see ¶ [0017] and claims 13-14).

Thus, Tatsumisago et al. do not anticipate the claimed crystallized glass.

(3) Tatsumisago et al. do not make the claimed crystallized glass obvious.

(a) Concerning the disclosure of Hayashi et al., discussed below, and the Office arguments on page 4, last paragraph, the fact that two compositions which have the first and second highest conductivities,  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 75 \text{ mol.\%} : 25 \text{ mol.\%}$  and  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 80 \text{ mol.\%} : 20 \text{ mol.\%}$ , are outside of the claimed ranges is at least one basis for the non-obviousness of the claimed crystallized glass. Specifically, a skilled artisan would not have been motivated to use the claimed ranges because the composition  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 70 \text{ mol.\%} : 30 \text{ mol.\%}$  has the lowest conductivity of the three compositions described in Figure 4 of Hayashi et al.

This arguments was presented during a discussion with the Examiner on May 17, 2011, and the Examiner indicated that the Applicants' argument on pages 6-7 were misunderstood.

(b) Although Tatsumisago et al. describe glass formed from  $\text{Li}_2\text{S} : 80 \text{ mol\%}$  and  $\text{P}_2\text{S}_5 : 20 \text{ mol\%}$ , the claimed crystallized glass is not obvious in view of this disclosure.

For an electrolytes (glass) for lithium ion batteries, the more Li ion the electrolyte contains, the higher the ion conductivity thereof becomes (see page 478, lines 3 to 9 of the right column of attachment 1, A. Hayashi, and M. Tatsumisago, "A High Lithium Ion Conductivity Of Sulfide-based Glass Ceramic Solid Electrolytes", Metal, 2005, vol. 75, No. 4, p.351-354, submitted herewith).

The same dependency applies to a sulfide-based solid electrolyte (glass). As shown in Fig. 4 of attachment 1, when an electrolyte is produced by using the same materials, the ion conductivity thereof becomes the highest when  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 75 \text{ mol\%} : 25 \text{ mol\%}$ , the secondly highest when  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 80 \text{ mol\%} : 20 \text{ mol\%}$  and the thirdly highest when  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 70 \text{ mol\%} : 30 \text{ mol\%}$ . The reason why the sulfide-based glass formed from  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 75 \text{ mol\%} : 25 \text{ mol\%}$  is higher in ion conductivity than the sulfide glass formed from  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 80 \text{ mol\%} : 20 \text{ mol\%}$  is because of the unreacted  $\text{Li}_2\text{S}$  presents in the latter. The reason

why the sulfide glass formed from  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 85 \text{ mol\%} : 15 \text{ mol\%}$  is low in ion conductivity is because a lot of  $\text{Li}_2\text{S}$  remains in the glass.

The reason why the ion conductivities of the sulfide glass formed from  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 80 \text{ mol\%} : 20 \text{ mol\%}$  and the glass formed from  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 75 \text{ mol\%} : 25 \text{ mol\%}$  are almost the same is that the former has more lithium ions than the latter although the former contains remaining  $\text{Li}_2\text{S}$ .

Thus, glass ceramics are not always high in ion conductivity when the content of lithium ion is high. However, in this technical field, at the time of the invention, it was believed that when a sulfide-based solid electrolyte (glass) is heated, not all glass is crystallized but only at most 50% of the glass.

For this reason, in order to improve ion conductivity, a person skilled in the art would have tried to heat glass formed from a mixture of  $\text{Li}_2\text{S} : \text{P}_2\text{S}_5 = 75 \text{ mol\%} : 25 \text{ mol\%}$  to  $80 \text{ mol\%} : 20 \text{ mol\%}$ , particularly, a mixture of near  $80 \text{ mol\%} : 20 \text{ mol\%}$  for crystallization, but would not have tried to heat glass formed from the mixture having the claimed composition  $\text{Li}_2\text{S} : 68 \text{ to } 74 \text{ mol\%}$  and  $\text{P}_2\text{S}_5 : 26 \text{ to } 32 \text{ mol\%}$  to improve the ion conductivity thereof.

Thus, Tatsumisago et al. do not make the claimed glass obvious.

In addition, Fig. 1 of the attachment 2 (A. Hayashi, and M. Tatsumisago, "A High Lithium Ion Conductivity Of Sulfide-based Glass Ceramic Solid Electrolytes", Metal, 2005, vol. 75, No. 4, p.351-354, published after the filing of the present application, submitted herewith) shows that the more  $\text{Li}_2\text{S}$  is used as the material of glass ceramics (up to  $80 \text{ mol\%} : 20 \text{ mol\%}$ ), the higher the ion conductivity becomes.

Thus, the ion conductivity provided by the claimed glass would not have been reasonably expected from the claimed material composition and crystallization based on the disclosure of the cited references and knowledge in the field of crystallized glass at the time of the present invention. Thus, it would not have been reasonable to expect, based on the

disclosure of Tatsumisago et al., that the crystallized glass formed from materials having the claimed composition would have had high ion conductivity. Thus, the claimed crystallized glass provides an unexpected result.

(4) The crystallized glass is obtained by heating glass, and the glass can be obtained by mechanical milling raw materials,  $\text{Li}_2\text{S}$  and  $\text{P}_2\text{S}_5$ , as explained in the present specification.

The glass does not comprise  $\text{Li}_2\text{S}$  and  $\text{P}_2\text{S}_5$  as separate compounds, but comprises a product resulting from the reaction of  $\text{Li}_2\text{S}$  and  $\text{P}_2\text{S}_5$  which is a composite-type product of  $\text{Li}_2\text{S}$  and  $\text{P}_2\text{S}_5$ .

Concerning Kugai et al., the Kugai et al. electrolyte is produced by the vacuum deposition or a similar method, i.e., by a reaction of materials in the gas or ion state. However, the claimed electrolyte is produced by a reaction of solid materials. Thus, the production method of Kugai et al. is significantly different from the method of the present application and, therefore, the structure of the electrolyte of Kugai et al. is different from that of the present invention.

For example, in Kugai et al., the ion conductivity of the non-thermally treated electrolyte is substantially the same as that of the thermally treated electrolyte. However, the ion conductivity of crystallized glass that has been thermally treated according to the present invention is remarkably higher than that of non-thermally treated glass. Thus, it is clear that the Kugai et al. electrolyte has a structure different from that of the claimed crystallized glass.

Thus, a skilled artisan would not have been motivated to combine the disclosures of Tatsumisago et al. and Kugai et al. with a reasonable expectation of success, because these references describe completely different structures.

Thus, Tatsumisago et al. do not anticipate or make the claimed crystallized glass, batteries, and method obvious. Moreover, Tatsumisago et al. and Kugai et al. do not make the claimed crystallized glass obvious.

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Applicants request that the rejections be withdrawn.

A Notice of Allowance for all pending claims is requested.

Respectfully submitted,

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